REMARKS

This application has been carefully reviewed in light of the Office Action dated November 7, 2008. Claims 1-15 remain in this application. Claims 1 and 14 are the independent Claims. It is believed that no new matter is involved in the arguments presented herein.

Reconsideration and entrance of the amendment in the application are respectfully requested.

Art-Based Rejections

Claims 1, 3, and 8 were rejected under 35 U.S.C. § 103(a) over U.S. Patent No. 4,776,894 (Watanabe) in view of U.S. Patent No. 4,926,230 (Yamagishi); Claims 2 and 4-7 were rejected as Claim 1, and further in view of JP Pub. No.59-35016 (Nakamura); Claim 10 was rejected as Claim 1, and further in view of U.S. Patent No. 4,875,944 (Yoshida); Claims 11 – 13 as Claim 1, and further in view of JP Pub. No. 2002-170973 (Kondo); Claims 14-15 were rejected under 35 U.S.C. § 103(a) over EP 1,198,014 (Hayashi) in view of Watanabe and Yamagishi.

Applicant respectfully traverses the rejections and submits that the claims herein are patentable in light of the arguments below.

The Watanabe Reference

Watanabe is directed to a photovoltaic device having a plurality of unit photovoltaic cells layered in optical series. Each unit photovoltaic cell includes an optically active layer made of amorphous silicon and two impurity doped layers of opposite conductivity types arranged at opposite sides of the optically active layer. A first impurity doped layer of a first unit photovoltaic cell locates at the contact interface with a second unit photovoltaic cell and is made of a first amorphous silicon alloy of first conductivity type. A second impurity doped layer of the second photovoltaic cell locates

at the contact interface and is made of a second amorphous silicon alloy (*Watanabe Abstract*).

The Yamagishi Reference

Yamagishi is directed to a photovoltaic device of amorphous or microcrystalline semiconductor having multi-junction. One or more layers having high concentration impurities is interposed between p-type conductive layer and n-type conductive layer. A tunnel junction is formed by the interposed layer to improve the photo-electric conversion rate (*Yamagishi Abstract*).

The Nakamura Reference

Nakamura is directed to the preparation of silicon layer by vacuum metallization of silicon, CVD, or plasma. The preparation includes a first stage of keeping the silicon layer at 480-600 degree C and converting the silicon to crystalline. The second stage includes heat-treating the silicon in a plasma atmosphere containing hydrogen or its isotope at approximately the crystallite formation temperature of silicon (*Nakamura machine translation of CONSTITUTION section*).

The Yoshida Reference

Yoshida is directed to an amorphous photoelectric converting device that remains efficient despite exposure to heat over long periods of time. The device is formed by placing one on top of the other a plurality of photovoltaic elements each including a thin film of p-i-n structure. The p-type layer and the n-type layer of adjacent elements are made of microcrystalline silicon so that good ohmic contact is established, and the p-type layer of microcrystalline silicon contains boron in an amount sufficient to neutralize the donor atoms diffused from the adjacent n-type layer when the device is left to stand at high temperatures for a long period of time. The amount of boron,

however, is limited to such an extent that the boron atoms do not adversely affect the initial desired characteristics of the device (*Yoshida Abstract*).

The Kondo Reference

Kondo is directed to a method of forming a semiconductor device having a silicon and two or more p-i-n junctions. The process includes the step of putting the p-type layer or n-type layer exposed to the surface of the p-i-n junction in an oxygen atmosphere after forming a p-i-n junction (*Kondo machine translation, paragraph [0008]*).

The Hayashi Reference

Hayashi is directed to a photovoltaic module including a transparent substrate and hybrid-type photovoltaic cells arrayed on the substrate and connected in series to each other. The cells includes a back electrode facing the substrate, a transparent front electrode intervening between the substrate and the back electrode, a first photovoltaic layer between the front and back electrodes and comprising an amorphous semiconductor layer. A second photovoltaic layer is disposed between the first photovoltaic layer and the back electrode and is formed of a crystalline semiconductor layer. A conductive interlayer with a light-transmitting-and-reflecting property is disposed between the first and second photovoltaic layers and having a thickness in a range of 10 nm to 100 nm and a specific resistance in a range of 1×10^{-3} Ω·cm to 1×10^{-1} Ω·cm (*Hayashi paragraph 57*).

The Claims are Patentable Over the Cited References

The present application is generally directed to a stacked-layer type thin-film photoelectric conversion device having improved conversion efficiency.

As defined by independent Claim 1, a stacked-layer type photoelectric conversion device includes a plurality of photoelectric conversion units stacked on a

substrate, each of which includes a one conductivity-type layer, a photoelectric conversion layer of substantially intrinsic semiconductor, and an opposite conductivity-type layer in this order from a light incident side. At least one of the opposite conductivity-type layer in a front photoelectric conversion unit arranged relatively closer to the light incident side and the one conductivity-type layer in a back photoelectric conversion unit arranged adjacent to the front photoelectric conversion unit includes a silicon composite layer at least in a part thereof. The silicon composite layer has a thickness of more than 20 nm and less than 130 nm and an oxygen concentration of more than 25 atomic % and less than 60 atomic %, and includes silicon-rich phase parts in an amorphous alloy phase of silicon and oxygen.

The applied references fail to disclose or suggest the above features of the claims of the present invention. In particular, the applied references fails to disclose or suggest the opposite conductivity-type layer in a front photoelectric conversion unit or the one conductivity-type layer in a back photoelectric conversion unit including a silicon composite layer, and the silicon composite layer has "a thickness of more than 20 nm and less than 130 nm and an oxygen concentration of more than 25 atomic % and less than 60 atomic %, and includes silicon-rich phase parts in an amorphous alloy phase of silicon and oxygen" as recited in Claim 1.

The Action maintained the rejection of Claim 1 over the combination of Watanabe and Yamagishi. Applicant respectfully disagrees with the Action's position and traverses the rejection.

(1) Watanabe and Yamagishi cannot be combined as proposed because such the proposed combination renders the prior references unsatisfactory for its intended purpose (*see MPEP § 2143.01 V*). It is well established that if the proposed modification would render the prior art invention unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. Ibid.; see *In re Gordon*, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984). There, the claimed

device was a blood filter assembly for use during medical procedures wherein both the inlet and outlet for the blood were located at the bottom end of the filter assembly, and wherein a gas vent was present at the top of the filter assembly. The prior art reference taught a liquid strainer for removing dirt and water from gasoline and other light oils wherein the inlet and outlet were at the top of the device, and wherein a pet-cock (stopcock) was located at the bottom of the device for periodically removing the collected dirt and water. The reference further taught that the separation is assisted by gravity. The appeal board concluded that the claims were *prima facie* obvious, reasoning that it would have been obvious to turn the reference device upside down. The court reversed, finding that if the prior art device was turned upside down it would be ***inoperable for its intended purpose*** because the gasoline to be filtered would be trapped at the top, the water and heavier oils sought to be separated would flow out of the outlet instead of the purified gasoline, and the screen would become clogged. *Ibid.*

The "inoperable for its intended purpose" standard is applicable here. The Action proposed to modify Yamagishi's interface layer to 10-30 atomic % Oxygen, as taught by Watanabe. (According to the Action, Yamagishi teaches a silicon composite layer a having thickness of 7-70 nm. Watanabe teaches the silicon composite layer having 10-30 % of oxygen. The Action proposes combining these two limitations, as constructed by the Action, to obtain the features of Claim 1). The proposed oxygen concentration, however, would ***render Yamagishi inoperable for its intended purpose***, as in *Gordon*. Yamagishi teaches the interface layer thickness and that the oxygen concentration in the interface layers is 1-10 atomic % (*Yamagishi col. 2, lines 60-65*); well off from the 25 - 60 atomic % recited in Claim 1. Moreover, Yamagishi proscribes random modification of the thickness and oxygen concentration. Specifically, Yamagishi states "The preferred impurity concentration depends on the type of impurity that has been introduced and on the thickness of the high impurity concentration layer, and **therefore its range cannot be defined unconditionally**." (*Yamagishi col. 2, lines 50-53; emphasis added*). The proposed modification of the oxygen concentration runs

afoul of Yamagishis proscription against unconditional modification. Accordingly, Yamagishi cannot be modified to obtain the 25 - 60 atomic % oxygen concentration recited in Claim 1.

The Office Action contends that that *Yamagishu* teaches a thickness in the range of 7 nm to 70 nm (*See, Office Action, page 3, lines 16-17*). Applicant respectfully traverses this contention. As one of ordinary skill would readily realize, such thickness range corresponds to the entire n-type (2) or p-type (3) layer, and the thickness of "high impurity concentration layer" which includes oxygen is 1 nm to 30 nm (*See, Yamagishi, Col. 2, lines 38-41; Claim 3*).

This is because one of ordinary skill in the art would appreciate that Yamagishi discloses three types of "high impurity concentration layers," having

(a) p-type dopant as impurity and thickness of 1-30 nm (See, Yamagishi, Co.. 2, lines 29-32);

(b) n-type dopant as impurity and thickness of 1-50 nm (See, Yamagishi, Col. 2, lines 32-36); and

(c) Cu, Fe, O, N or Ge as impurity and thickness of 1-30 nm (See, Yamagishi, Col. 2, lines 16-22 and 38-41).

Accordingly, Yamagishi does not disclose the above features of independent Claim 1 of the present invention.

(2) Moreover, the combination of Watanabe and Yamagishi proposed by the Action is improper for the lack of reasonable expectation of success. That expectation of success has long being the indicium of nonobviousness in patent law. *See MPEP § 2143.01; 2143 A, Example 1 stating "Note that combining known prior art elements is not sufficient to render the claimed invention obvious if the results would not have been predictable to one of ordinary skill in the art;" MPEP § 2143.02 Reasonable Expectation of Success is Required.* The Action at pages 3 and 11 argues that Yamagishi's teaching allows persons of ordinary skill in the art to experiment with the thickness and

oxygen concentration of the silicon composite layer. That suggestion to experiment, however, is insufficient to indicate success for the particular combination of layer thickness and oxygen concentration proposed by the Action; there is no indication in Yamagishi that experimentation would yield a working layer with a thickness of 20 - 130 nm and an oxygen concentration of 25 - 60 atomic %. On the contrary, Yamagishi teaches a layer having a thickness of 7-70 nm (according to the Action) and an oxygen concentration of 1-10 atomic %, **which falls well outside of the range recited in Claim 1, and warns against arbitrarily altering that thickness and oxygen concentration**.

In particular, Applicant respectfully notes that MPEP § 2143.02 II states unequivocally that "Obviousness does not require absolute predictability, however, at least some degree of predictability is **required**," (emphasis added). In that regard, Yamagishi's warning against arbitrarily altering the thickness and oxygen concentration clearly indicates that there is no predictability or reasonable expectation of success when one randomly modifies the layer thickness and oxygen concentration as the Action proposes.

Moreover, Applicant respectfully submits that the teaching of Yamagishi serves to bar against the combination of Watanabe and other prior references teaching similar thickness. Yamagishi casts doubt on the expectation of success of a silicon composite layer having a thickness and oxygen concentration other than the 7-70 nm (according to the Action) and the 1-10 atomic % taught by Yamagishi; such doubt further highlight the nonobviousness of features recited in Claim 1.

(3) Furthermore, Applicant respectfully submits that the Action has not established prima facie obviousness of Claim 1 by failing to state proper motivation of combine. The Action at page 3 argues that the motivation to combine includes (a) using the claimed thickness range to increase the active regions of the cells and (b) "the

thickness range is dependent on the dopant concentration, as taught by Yamagishi." Applicant traverses.

Regarding (a), Applicant is at loss and is in need of further clarification from the Office. Applicant does not understand what "cells" or "active regions" the Action is referring to. Those terms were not mentioned elsewhere in the Action (in patent parlance, they lack antecedent basis), and the Action provided no citation in Watanabe and Yamagishi. Moreover, the Action fails to state how increasing this "active regions" would be of any advantage to the devices taught by Yamagishi and Watanabe. Making modification for the sake of making modification is not motivation. Accordingly, Applicant respectfully requests the Office to provide citations for the "cells" or "active regions," and the advantages provided by the increased "active regions" in the "cells." Failing that, the rejection of Claim 1 should be withdrawn.

Regarding (b), Yamagishi merely states a relationship between impurity concentration and impurity layer thickness. By itself, Yamagishi does not teach or suggest that the oxygen concentration of 10 – 30 % taught by Watanabe is more desirable than the 1-10 atomic % taught by Yamagishi.

In sum, mere mentions of "cells," "active regions," and the relationship between impurity concentration and impurity layer thickness, without more, are insufficient motivation to combine.

(4) Even when Watanabe and Yamagishi are combined, the prior references still do not teach or suggest all the features of Claim 1. Specifically, Applicant submits that Watanabe does not teach or suggest the oxygen concentration of 25 - 60 atomic % recited in Claim 1. Watanabe teaches oxygen concentration of 10 -30 %, but fails to teach or suggest the atomic percentage as recited in Claim 1. The oxygen concentration of 10 - 30 % may refer to weight percentage, volume percentage, and infinite other possibilities. The Action asserts that the 10 - 30 % refers to atomic percentage; Applicant respectfully submits that assertion is baseless. Applicant further

submits that, at the very least, an Official Notice is required to assert that the oxygen concentration of 10 – 30 % refers to atomic percentage. Failing that, the rejection of Claim 1 should be withdrawn.

The ancillary references are not seen to remedy the deficiencies of Watanabe and Yamagishi. For the reasons above, Claim 1 is allowable over Watanabe and Yamagishi, and such allowance is respectfully requested. Claim 14 recites similar features as Claim 1 discussed above, and is thus also allowable over the applied reference. Allowance of Claim 14 is respectfully requested.

The remaining claims depend directly or indirectly from Claims 1 and 14, and are therefore allowable at least for the same reasons as base Claims 1 and 14. The allowance of those claims is respectfully requested.

Claims 11 and 12

As discussed above, Claims 11 and 12 are allowable per the allowance of the base Claim 1. Moreover, Claims 11 and 12 are allowable because the applied references do not teach or suggest all the features of those claims. In particular, the applied references do not teach or suggest the step "wherein said substrate, having said silicon composite layer deposited to a part of its total thickness in a plasma CVD reaction chamber, is temporarily taken out to expose a surface of said silicon composite layer to the ambient air."

The applied Kondo reference discloses the steps of a) deposition of n-type (or p-type) layer; b) exposure to the ambient air; and c) deposition of p-type (or n-type) layer.

In contrast, according to the present invention a single layer (silicon composite layer) is deposited by steps of: a) deposition of the first part (in thickness) of a (silicon composite) layer; b) exposure to the ambient air; and c) deposition of the second part (remaining part) of said (silicon composite) layer.

As one of ordinary skill in the art would readily appreciate, it is clear that the exposure of *Kondo* is processed between the depositions of one conductivity-type layer and another conductivity-type layer, i.e., exposure is processed after a whole deposition of one conductivity-type layer. In contrast, exposure of present invention is processed during the course of a deposition of one (silicon composite) layer.

Therefore even if a person skilled in the art combined the teaching of Watanabe and Kondo, he or she would process the exposure before or after the deposition of silicon composite layer, not during the course of the deposition.

Advantageously, the "during the course" exposure feature of the present invention brings an unexpected result. As disclosed in Table 7 of present application, Samples 6A, 7A, 8A, and 2A of present invention shows higher photoelectric conversion efficiency than Comparative Samples 03A and 04A, which appears to be taught by *Kondo*.

On page 8, the Office Action states the follows:

> Kondo teaches having the silicon composite layer deposited to a part of its total thickness in a plasma CVD reaction ¶ [0008] chamber is temporarily taken out of exposed a surface of the silicon composite layer to the ambient air and then after the substrate is introduced again into composite layer to the ambient air and then after the substrate is introduced again into a plasma CVD reaction chamber the remaining part of the total thickness of the silicon composite layer is deposited and that the substrate is taken out from the plasma CVD reaction chamber to the ambient air after 60%. . . .

The Action's position fails, because Kondo does not even teach or suggest a "silicon composite layer," let alone one that is part of the one conductivity-type layer in a back photoelectric conversion unit arranged adjacent to the front photoelectric conversion unit, as recited in Claim 1. FIG. 3 of Kondo illustrates two stacked p-i-n devices. One p-i-n device includes 102-1, 102-2, and 102-3 layers; the other p-i-n device includes 102-4, 102-5, and 102-6 layers. The 102-2 and 102-5 layers are the i-type layers; the 102-1 and 102-4 layers are the first conductivity-type semiconductor

payer (p or n), and the 102-3 and 102-6 layers are the second conductivity-type semiconductor (n or p). (*See Kondo machine translation para. [0045], and Figure Explanation at page 12*). Similarly, FIG. 6 of Kondo illustrates two stacked p-i-n devices formed by the 102-1A - 102-2A – 102-3A layers and 102-4A - 102-5A – 102-6A layers. **The "silicon composite layer" is notably absent in the figures of Kondo.**

On the other hand, it is clear that Kondo's teaching cited by the Action is directed to the p or n layer of the p-i-n device. Kondo at para. [0008] states "A process of putting p layer (p type semiconductor layer) or a n layer (n type semiconductor layer) exposed to the surface of this pin junction to an oxygen containing atmosphere after forming a pin junction of one among said pin junctions. A formation method of a semiconductor device having the process of forming other n layers or players of a pin junction which adjoin said pin junction of 1, and forming pn interface on p layer put to this oxygen containing atmosphere or a n layer is provided." (*See Kondo machine translation para. [0008]; similar disclosure is stated in paras. [0009] and [0010]*).

Accordingly, Kondo discloses that the p-layer or n-layer of a p-i-n device being exposed to the atmosphere, before the opposite conductivity-type layer is deposited. In the present invention, by contrast, the silicon composite layer is once exposed to the atmosphere at an intermediate state of deposition thereof. As an example, Applicant respectfully refers the Examiner to Applicant's specification, FIG. 10 (discussed at page 28, line 21 – page 29, line 5). In that figure, a silicon composite layer 4 is disposed between devices 3 and 5; the silicon composite layer 4 is not taught or suggested in Kondo absent in all figures of Kondo.

Since Kondo does not even teach or suggest the "silicon composite layer" as recited in Claim 4, Kondo cannot teach or suggest features related to the formation of that layer in Claims 11 and 12. Accordingly, Claims 11 and 12 are allowable over the applied references including Kondo, and such allowance is respectfully requested.

Conclusion

Applicant believes the foregoing amendments comply with requirements of form and thus may be admitted under 37 C.F.R. § 1.116(b). Alternatively, if these amendments are deemed to touch the merits, admission is requested under 37 C.F.R. § 1.116(c). In this connection, these amendments were not earlier presented because they are in response to the matters pointed out for the first time in the Final Office Action.

Lastly, admission is requested under 37 C.F.R. § 1.116(b) as presenting rejected claims in better form for consideration on appeal.

In view of the foregoing, it is respectfully submitted that the application is in condition for allowance. Reexamination and reconsideration of the application, as amended, are requested.

If for any reason the Examiner finds the application other than in condition for allowance, the Examiner is requested to call the undersigned attorney at the Los Angeles, California telephone number (310) 785-4721 to discuss the steps necessary for placing the application in condition for allowance.

If there are any fees due in connection with the filing of this response, please charge the fees to our Deposit Account No. 50-1314.

Respectfully submitted,
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